Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/442
BELGIUM
February 1964
Original: FRENCH

Confidential until official release during Conference

Abstract

DESIGN AND FABRICATION OF PWR FUEL ELEMENTS IN BELGIUM

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Belgium is particularly interested in the development of uranium oxyde PWR reactors.

This trend has been followed since the decision to build the BR-3 and SENA reactors. The development of the VULCAIN project has stimulated the interest in this type of reactor.

In this field, M.M.N. has developed and fabricated up to now :

- the fuel loading for the VENUS critical experiment in relation with the VULCAIN project,
- the loading of the VULCAIN power exepriment in the BR-3 and
- a prototype fuel element for the BR-3 reactor.

The latter element, built according to the latest design and engineering methods evolved for the SENA core, includes twelve plutonium fuel rods developed by the Association BelgoNucleaire-C.E.N. and is of a different type than the original elements. It has been introduced in the central part of the BR-3 core amongst elements of the original design.

B.E.N. has carried out the theoritical studies relative to its behaviour in the reactor from the various nuclear, hydraulic and thermal points of view.

The problems encountered in the fabrication and the study of this fuel

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element are the subject of this paper.

The fabrication is based on the following principles : the fuel rods, consisting of uranium oxyde pellets enclosed in thin walled stainless steel tubes, form a bundle held in an independent perforated can, allowing free thermal expansion of the rods. The tubes are positioned by six intermediate spacing grids with integral spring clips. Stainless steel is used for the tubes, can and grids.

The element will be irradiated until depletion of the present BR-3 core, corresponding to a burnup of approximately 5.000 MWD/T for the experimental fuel element. This test of about 4,000 full power hours will provide a check of the mechanical behaviour of this type of element in a power reactor.

The introduction of an element so different from the original ones results in an heterogeneity which in general tends to reduce the maximum power capability of the core. It was therefore necessary to perform a theoretical study to verify the operating safety of the new core configuration at the plant rated power. The following aspects have been investigated :

- The nuclear study has for objective the determination of the local power peaks and their variations during core life.
- The hydrodynamic study analyzes the coolant flow distribution between the various coolant channels.
- The thermal study combines the results of the two previous studies to locate the thermal hot channels. Its main purpose is to check, by means of the latest DNB (Departure from Nucleate Boiling) correlations published by Westinghouse, the operating safety of the core at rated power.

The operation of the reactor at full power, without any incident due to the presence of the new fuel element, has corroborated the suitability of the fabrication methods and the validity of the theoretical results.